ELECTRICAL POWER SUPPLY AND DEMAND FORECASTS FOR THE UNITED STATES THROUGH 2050

Hittman Associates, Inc.

ELECTRICAL POWER SUPPLY AND DEMAND FORECASTS FOR THE UNITED STATES THROUGH 2050

HIT-498

February 1972

Prepared Under
Contract No. EHSD 71-43
Environmental Protection Agency
Office of Air Programs

HITTMAN ASSOCIATES, INC.
COLUMBIA, MARYLAND

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I. INTRODUCTION

Over the past six decades, the United States has undergone a major growth in the technological ability to produce ever-increasing amounts of goods and services for distribution and consumption by the population. During these years, the demand for energy has grown in close relationship to increases in Gross National Product, as noted in Figure I-1. While the Gross National Product and electrical power production have increased by a factor of 10 in the years 1940 to 1970 (Ref. 1), the population has increased from 132 million in 1940 to about 205 million in 1970, an increase of about 50 percent. From population increments of around 15 percent per decade, the energy demands for the nation have approximately doubled during each decade (Ref. 2). This report has been prepared to explore the historical growth of the demand for electrical power, the trends in selection of power plant fuels by geographic distribution, projections of power demand growth into the twenty-first century, and the potential impacts on national air quality resulting from the various alternatives of fuel usage. In particular, power plants scheduled for construction from mid-1971 onward are surveyed to provide a basis for estimating the impact of national emission standards for sulfur dioxide on the electrical generating industry.

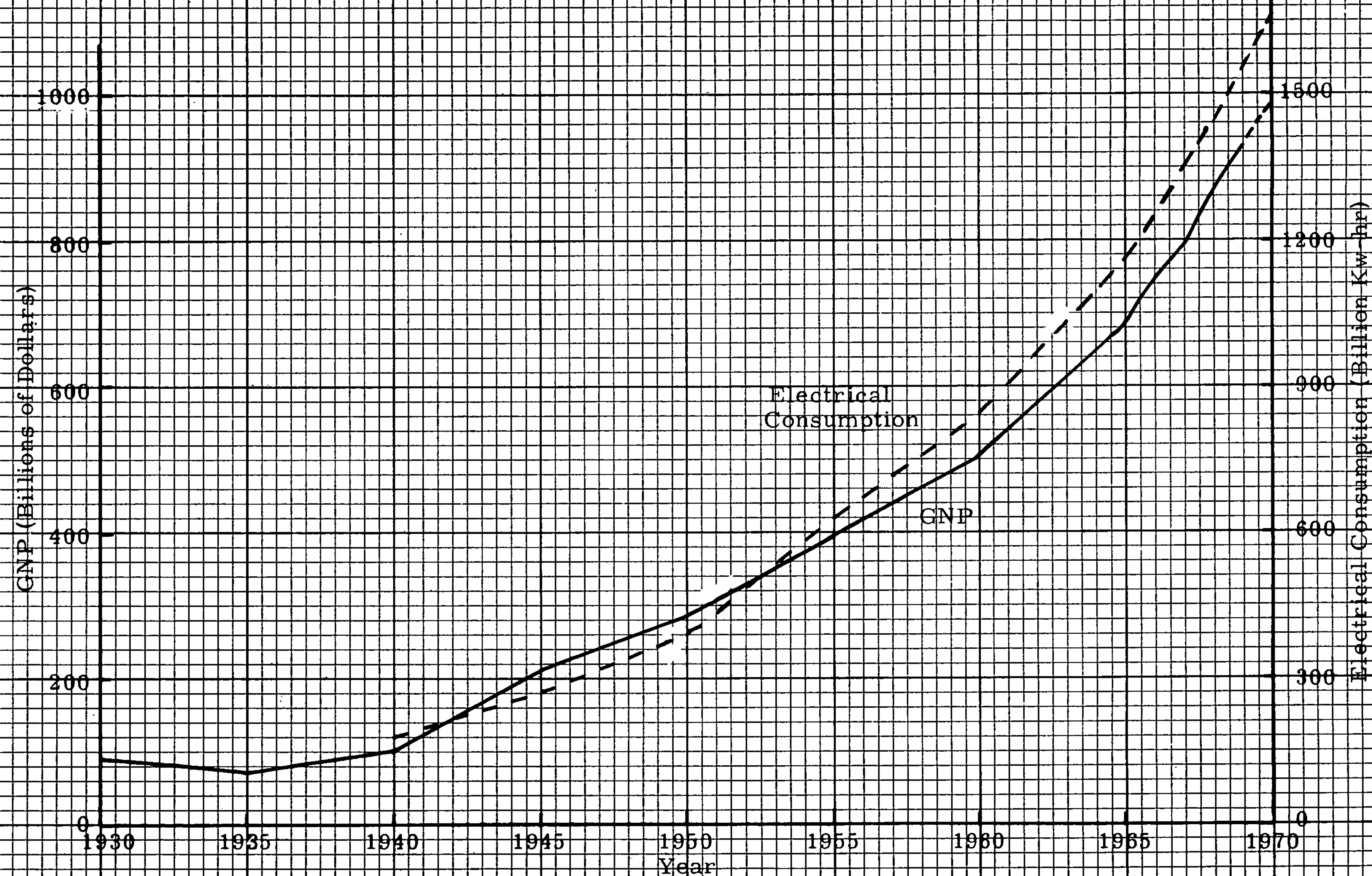


Figure I-1. Historic Growth of GNP and Electrical Consumption

II. BACKGROUND

During the period from 1900 through 1970, the population of the United States has grown from 106 million to over 205 million. The historical population growth curve is shown in Figure II-1. The Bureau of the Census periodically reviews population information and prepares a forecast of population growth to be expected over the next several decades. Based on a variety of assumptions, such as changes in birth and death rates, these population forecasts are shown in Figure II-2. It is unlikely that the Series B curve, which assumes a total childbearing production of 3100 per 1000 women (3.1 children per woman) will be achieved, partially due to the growing concern with the population explosion. Rather, it may be anticipated that something closer to a birth production of 2.5 to 2.7 children per woman will be realized over the next 50 or so years. For the purpose of this study, the Series C extrapolation was selected as being a reasonable yet relatively high population growth rate of 2775 children per 1000 women (over full fertility lifetime). From the Series C curve, the population was extrapolated by the Census Bureau through the year 2020, and was further extrapolated through 2050, although the reliability of these projections so far into the future is highly questionable. These extrapolations are shown in Figure II-3. From these data, it appears that the United States population will reach 432 million in 2030, 482 million in 2040, and 540 million in 2050. These data were used to provide the basis for power demand projections through the middle of the next century.

While population has grown at the rate of approximately 15 percent per decade, electrical generating capacity from stationary sources has been growing at a rate of over seven percent per year (Ref. 3), or almost doubling every 10 years. Historically, since 1955, the per capita power generation has been increasing at a somewhat startling rate, as shown in Table II-1 (Ref. 4). Much of this increase is attributable to the increased usage of electrically powered home convenience and comfort items such as air conditioners, electric can openers, etc.

From several sources (Refs. 5, 6, 7), including internally-generated extrapolations, projections of per capita installed capacity or per capita usage have been carried beyond the year 2000 to provide some means of estimating

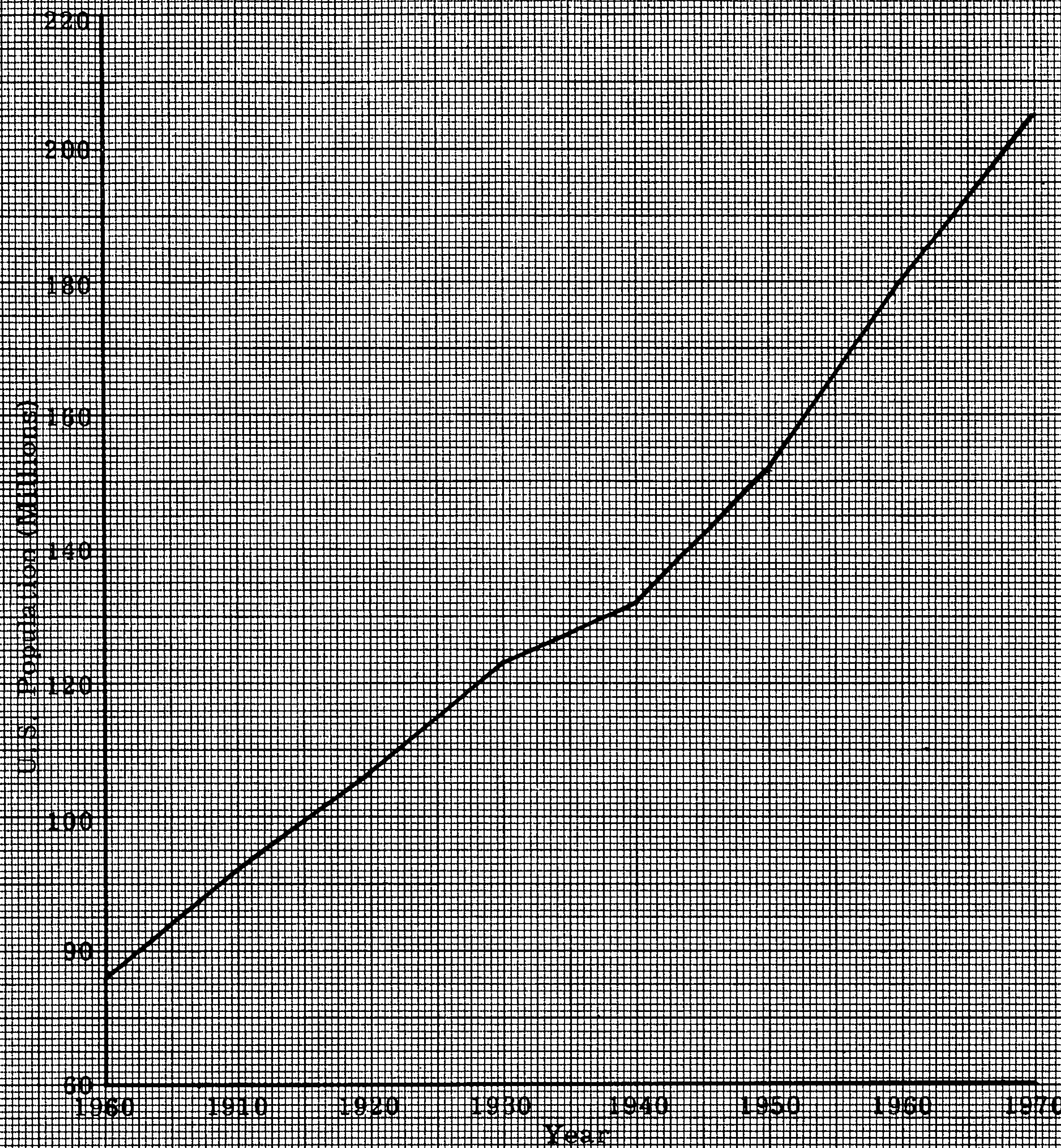


Figure II-1. U.S. Population Growth

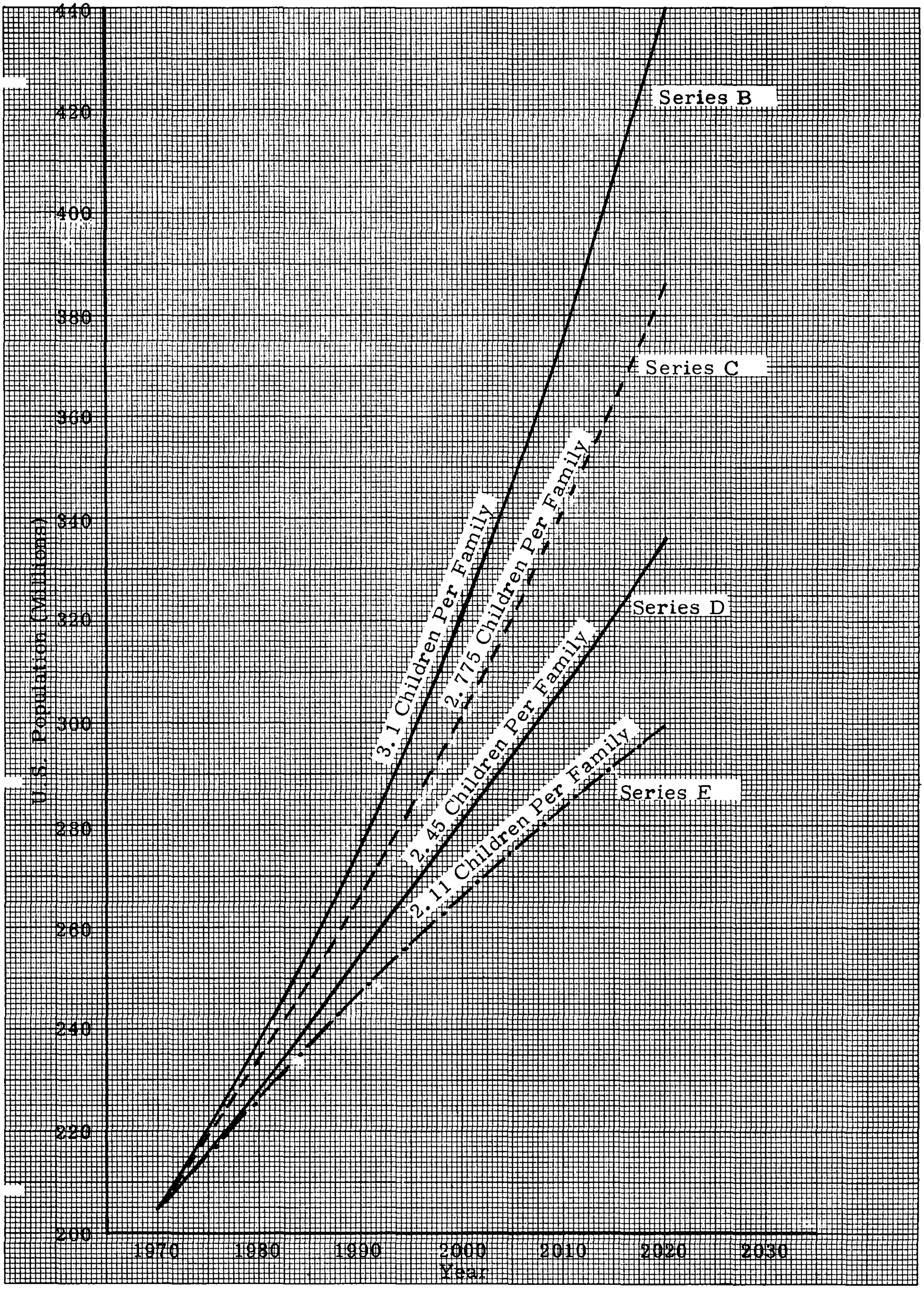


Figure II-2. U. S. Population Projections

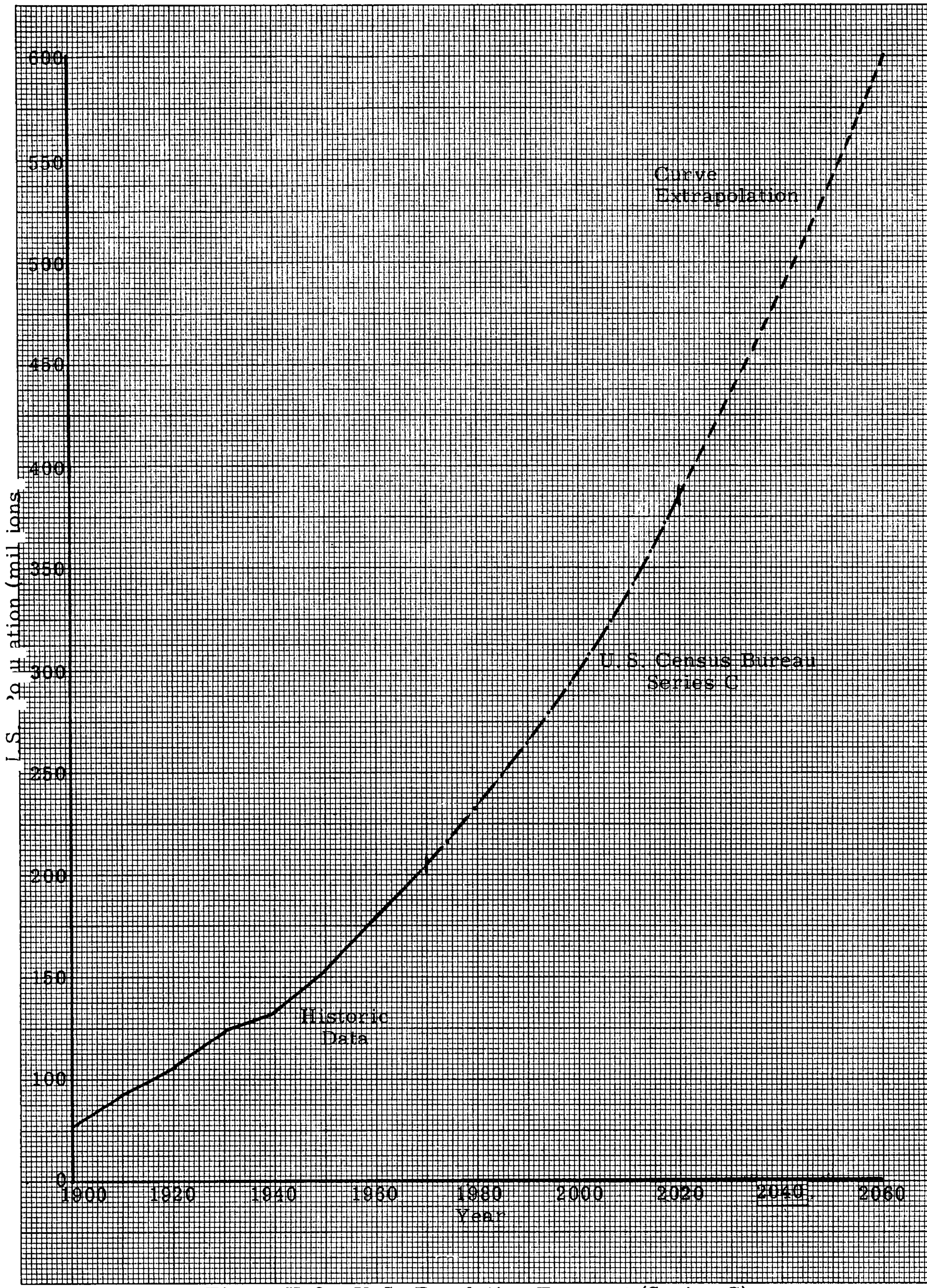


Figure II-3. U.S. Population Forecast (Series C)

TABLE II-1. PER CAPITA POWER GENERATION

Year	Population (10^6 people)	Kilowatt-hours per capita	Installed Kw per capita	Total Power Generated* (10^9 Kw-hr)
1955	164	3853	0.44	633
1960	180	4718	0.53	849
1965	194	5969	0.68	1157
1970	205	8100	0.93	1660
1975 (est)	221	10450	1.19	2310
1980 (est)	231	14000	1.60	3300

electrical power requirements beyond the end of this century. It should be noted that these projections are, at best, broad and subject to question. These data are shown in Figure II-4 and show curves of electrical power usage in reasonable agreement through about 1980 and then show some divergence beyond that time. Because of the expectations that improved engineering design will provide increasingly optimal usage of electrical power in future years, that technological improvements will provide greater reliability in generating and transmitting facilities, and that something approaching a saturation point of electrically-powered devices will be realized over the next century or so, judgements regarding the more probable ranges of per capita usage were made and are presented in Table II-2.

TABLE II-2. PER CAPITA ELECTRICAL POWER USAGE PROJECTIONS

	Kw Per Capita Usage			
Year	Most Probable	Maximum Expected	Minimum Expected	EEI
1970	0.9	0.9	0.85	
1980	1.5	1.6	1.25	1.35
1990	2.4	2.7	1.70	
2000	3.2	4.0	2.05	2.28-3.80
2010	4.0	5.0	2.60	
2020	5.0	6.0	3.00	
2030	6.0	7.0	3.50	
2040	6.8	8.0	3.85	
2050	7.8	9.0	4.20	

*Includes industrial generating capacity, ~10% of total

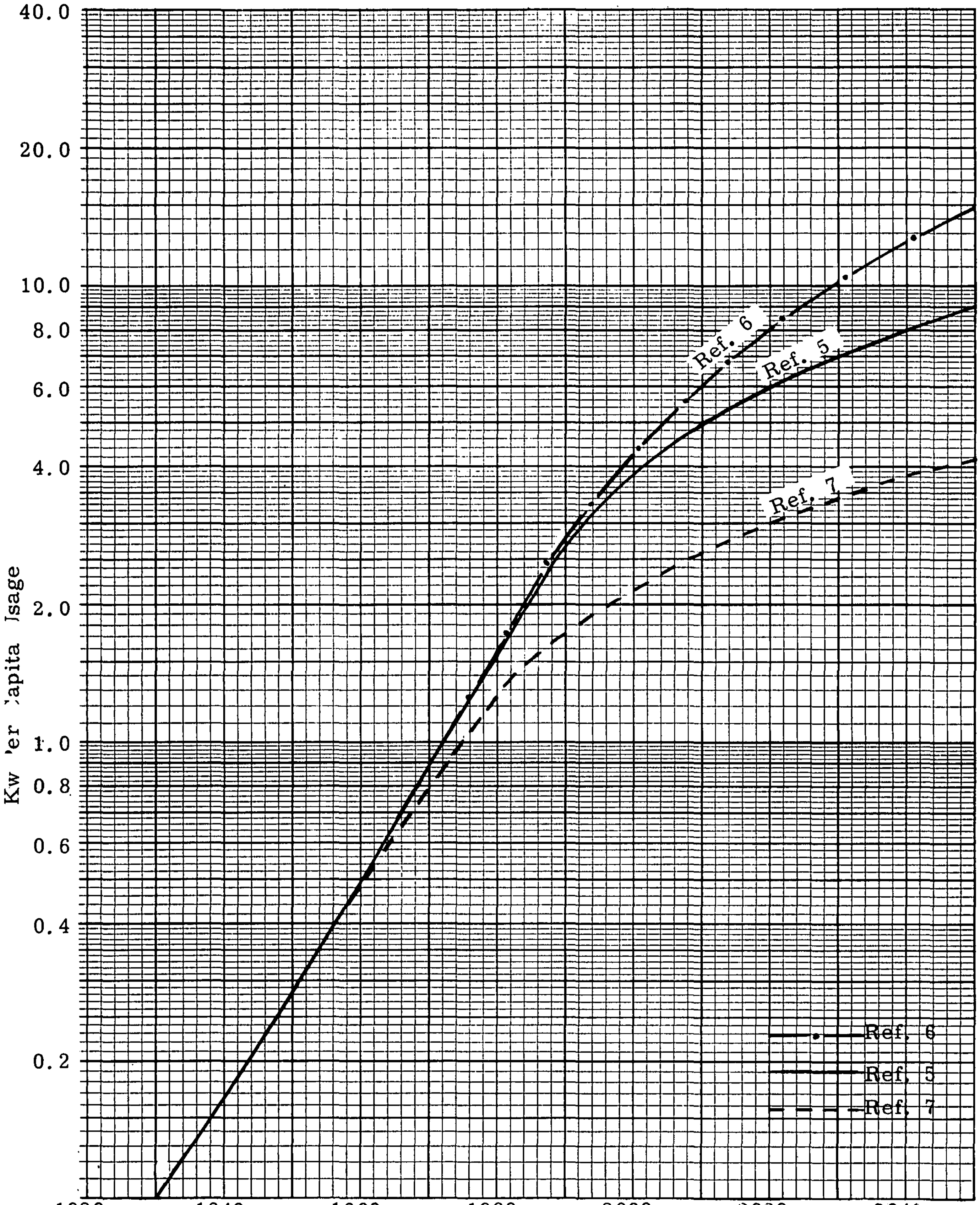


Figure II-4. Projections of Kw per Capita Usage

From the data shown in Table II-2 and the projections of United States population, projections were made, as shown below in Table II-3.

TABLE II-3. FORECAST GENERATING CAPACITY

a Year	b Population (10^6)	c Range of Estimated Per Capita Usage (Kw)	d Ranges of Total Estimated Usage (10^3Mwe)	e Plant Load Factor	f Range of Total Estimated Required Capacity (10^3Mwe)
1970	205	0.9-0.9	184-184	0.64	288-288
1980	232	1.6-1.3	371-302	0.64	580-475
1990	265	2.7-1.7	715-450	0.65	1100-700
2000	307	4.0-2.1	1220-650	0.66	1850-1000
2010	340	5.0-2.6	1700-885	0.68	2500-1300
2020	385	6.0-3.0	2310-1160	0.72	3220-1610
2030	432	7.0-3.5	3030-1515	0.78	4940-2410
2050	540	9.0-4.2	4860-2270	0.80	6100-2840

In the above table, the population figures in Column b are reasonable estimates based on Census Bureau forecasts, although the numbers become less reliable beyond the year 2000. The estimated range of per capita usage is based on previously noted sources and some judgement and extrapolation. Undoubtedly, these values will be subject to some question, particularly regarding long-range forecasts. However, there is some basis for these values. The higher values follow, to a reasonable degree, trends established by historical data and by examination of forecasts of electrical energy usage. Extrapolation of these data provided the higher set of values. Because it is somewhat risky to extrapolate long-range trends on an exponential growth curve, some economic evaluation was required to establish a relationship between the supply and the demand of electrical power. For example, Figure II-5 illustrates a possible shape of the long-term demand curve for electrical power usage. If, for example, the price of electricity is low, as in P_1, then the corresponding demand is high, as at Q_1. As the price of purchasing electrical power is forced up by such things as higher fuel, labor, or construction costs, then the demand can be expected to exhibit less elasticity as only necessary uses of power are exercised, and the income effects of higher power costs result in fewer unnecessary uses. In addition to the economic effect noted, there are reasonable expectations that technological advances will have the effect of reducing per capita uses away from the exponential growth curve toward somewhat lower values. For these reasons, it is felt that the ranges of total usage shown in Table II-3 provide an envelope of usage estimates. Again, it should be noted that these estimates tend to become highly unreliable beyond about 30 years in the future and become significantly more so as longer time periods are examined.

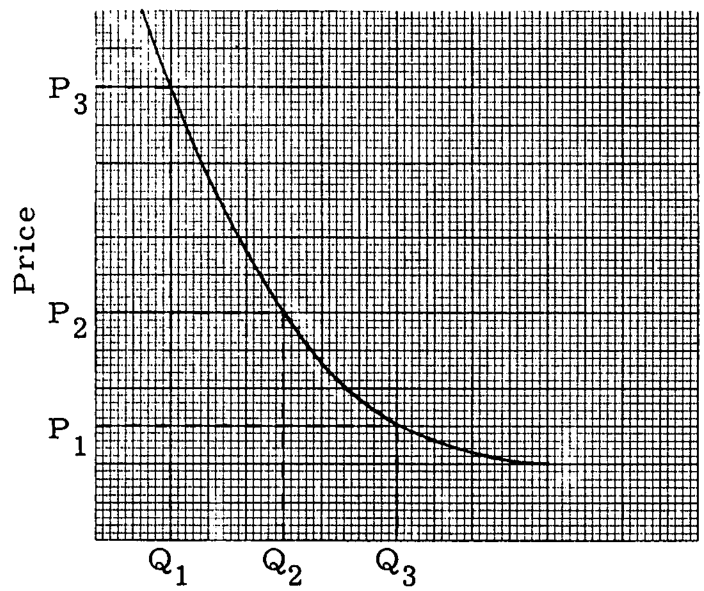


Figure II-5. Electrical Power Demand

It can be anticipated that Plant Load Factors (the percentage of time a generating plant is actually producing power) will tend to improve over the next 80 years as plant reliability increases and as other system improvements are realized. Therefore, the Plant Load Factor shown in Table II-3 (column e) was gradually increased from the existing value of about 64 percent to almost 80 percent in the year 2050. This would be particularly true if a substantial portion of generating capacity were nuclear-fueled at that time, since this type plant realizes greatest operating economies at higher load factors. Additionally, an assumption was made that significantly more improved transmission systems, load scheduling and shifting, and energy storage systems will gradually become available through technological advances.

Finally, column f of Table II-3 shows the range of estimated required generating capacities based on population and per capita use requirements through the year 2050.

The information provided in this section, as well as the forecasts of required electrical generating capacities, has provided the basis for information treated in subsequent sections.

In order to provide a more restrictive estimate of power demand over the next 80 years, Table II-4 summarizes the rationale for demand predictions based on estimates of most probable population, per capita usage, and plant load factors through 2050.

TABLE II-4. MOST PROBABLE POWER CAPACITIES

Year	Population (10^6)	Per Capita Use (10^6Kw)	Total Use (10^6Kw)	Plant Load Factor	Estimated Required Capacity (10^3Mw)
1970	205	0.9	185	0.64	320
1980	232	1.5	348	0.64	544
1990	265	2.4	636	0.65	978
2000	307	3.2	982	0.66	1488
2010	340	4.0	1360	0.68	2000
2020	385	5.0	1925	0.72	2674
2030	432	6.0	2592	0.75	3456
2040	482	6.8	3278	0.78	4203
2050	540	7.7	4158	0.80	5198

III. POWER USAGE CHARACTERISTICS

A. National Trends

Over the past 50 years, the demand for electrical power in the United States has been doubling each decade (Ref. 5). This corresponds to an annual average increment in power generating capacity of about 7.15 percent per year. It is expected that this growth rate will continue at a similar rate through at least the end of this century. Increased usage of personal comfort and convenience items in the home, the expansion of manufacturing and production capacities, and other factors have been, and will continue to be, major causative factors for this growth in power demand.

The percentage of total energy usage in this country presently consumed for electrical power generation is about 25 percent and is projected to reach 33 percent by 1980. This means that more fuels will be consumed for conversion to electrical power, rather than being consumed directly, as in motor vehicles and home heating units, indicating a trend toward more electrically-powered items in general usage throughout the country.

Information on the total electrical power generated and sold by the utility industry is given in Table III-1. Also included in this table are the ratios by year of installed capacity to peak load demand. During 1968, this ratio reached as low as 1.16, indicating that the demand was approaching the supply. Because of generating plant outages for maintenance or failure, the installed capacity is usually never completely available. Thus, the 1968 margin of 0.16 over demand is somewhat misleading and, in fact, during portions of the year, demand very nearly equalled available on-line supply.

Utility power sales may be categorized by usage. Typically, these categories are residential, industrial, commercial, and other usage. The breakdown of utility sales by category is shown in Table III-2. Table III-3 provides the same information, showing the sales by category as a percentage of the total. It is notable that, on a percentage of total basis, residential sales do not vary appreciably, while industrial sales trend significantly downward and commercial and other sales trend steadily upward. Residential sales include power for electric heating and other major appliances. The increasing

TABLE III-1. POWER UTILITY SALES, OUTPUT, AND CAPACITY (Ref. 5)

Year	Total Sales (10^9 Kw-hr)	Total Output (10^9 Kw-hr)	Installed Capacity (Mwe)	Peak Load (Mwe)	Installed Peak Load Ratio
1960	681	765	175,000	133,000	1.31
1965	950	1060	216,000	175,000	1.24
1968	1198	1327	279,000	238,000	1.17
1969	1302	1446	300,000	258,000	1.16
1970	1386	1540	325,000	275,000	1.19
1975 (est)	2013	2226	448,000	390,000	1.25
1980 (est)	2901	3200	681,000	544,000	1.24

TABLE III-2. POWER UTILITY SALES (10^9 Kw-hr) (Ref. 5)

Year	Residential	Industrial	Commercial	Other	Total
1960	195	344	114	27	681
1965	280	432	201	37	950
1970	442	575	310	60	1387
1975 (est)	649	810	458	97	2014
1980 (est)	915	1147	677	162	2901
1985 (est)	1229	1558	1002	277	4066

TABLE III-3. POWER UTILITY SALES (Percent) (Ref. 5)

Year	Residential	Industrial	Commercial	Other	Total
1960	28.6	50.5	16.8	4.0	100
1965	29.5	45.5	21.2	3.9	100
1970	31.9	41.5	22.4	4.3	100
1975 (est)	32.2	40.2	22.7	4.8	100
1980 (est)	31.5	39.5	23.3	5.6	100
1985 (est)	30.2	38.3	24.6	6.8	100

market for consumer comfort and convenience items, including air conditioning units, is expected to experience considerable growth and will have a marked effect on power usage. Table III-4 indicates the percent of total power sales which will be used to operate electrical heating and major appliances.

TABLE III-4. ELECTRIC HEAT AND MAJOR APPLIANCE USE (Ref. 5)

Year	% of Total Power Sales
1965	5.2
1970	5.5
1975 (est)	8.2
1980 (est)	10.8

In order to generate electrical power, various energy sources are utilized. Table III-5 indicates the total installed generating capacity (in 1970) for each of the major sources.

TABLE III-5. INSTALLED UNITED STATES GENERATING CAPACITY IN 1970 (Ref. 12) (In Megawatts Electrical)

Type	Total	Percent
Fossil steam	258,000	78.0
Gas turbine/diesel	12,000	3.6
Hydroelectric	54,000	16.3
Nuclear	7,000	2.1
Total	331,000*	100.0

*Approximate

B. Regional Changes in Power Usage

Power demand growth varies from one portion of the country to another. As illustrated by Figure III-1, based on one year changes in power output by Federal Power Commission regions, the smallest increase of 3.8 percent occurred in the Pacific Northwest, while the greatest change of 7.8 percent occurred in the Rocky Mountain region. The average national increment of power output amounted to 5.1 percent.

The net additions to generating capacity, the annual capital expenditures for power generation, and the cumulative installed fossil plant capacities are given in Table III-6. This table indicates a steady growth of fossil-fueled steam plants and then a levelling off during the decade of the 1970s. Nuclear plants are expected to grow from an existing two percent of installed capacity to almost 50 percent before the end of the twentieth century (Ref. 13). Notably, the increased use of gas-turbine and diesel generators by the utility industry to meet peak load demands has increased sharply over the past five years.

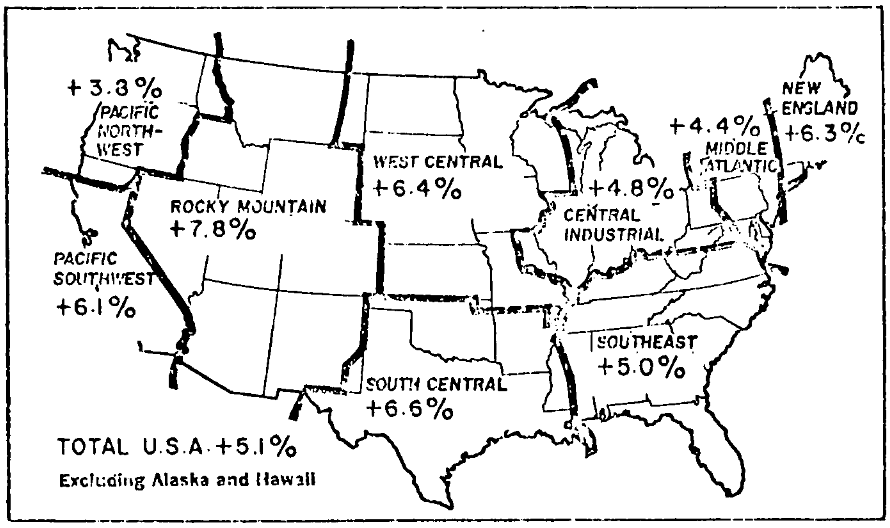
TABLE III-6. ADDITIONAL POWER GENERATING CAPACITY - USA (Ref. 5)

Generating Capacity net additions, Mw.
(Based on data of commercial operation)

Year	Fossil Steam	G.T. & I.C.	Hydro	Nuclear	Total	Capital Expenditures (10^9 $/yr)	Total Installed (Fossil) Capacity (Mw)
1960	9,431	18	1,348	316	11,113	2.22	-
1965	10,306	300	1,760	0	12,366	1.94	-
1970	16,302	5,650	1,696	2,252	25,900	6.04	268,000
1975	17,913	3,701	2,735	12,651	37,000	8.48	368,000
1980	16,718	4,200	2,161	18,921	42,000	10.40	478,000

Figure III-2 shows the expected trends of fuel usage from 1950 through 2000. Figure III-3 shows the variation of power demand as a function of time of year. During 1970, for example, the lowest weekly demand occurred early in May at 27 billion Kw-hr. During the heating season, the maximum demand was about 30.5 billion Kw-hr. The major demand peak, however, occurred

Powermap: Percent change in electric output by regions
for 52 weeks ended May 22



EEI Weekly Electric Output Index, seasonally adjusted (1967=100)

Week Ended	Index
May 1	134
May 8	132
May 15	129
May 22	131

Figure III-1. Percent Change in Electric Output by Regions for 52 Weeks Ending May 22, 1971

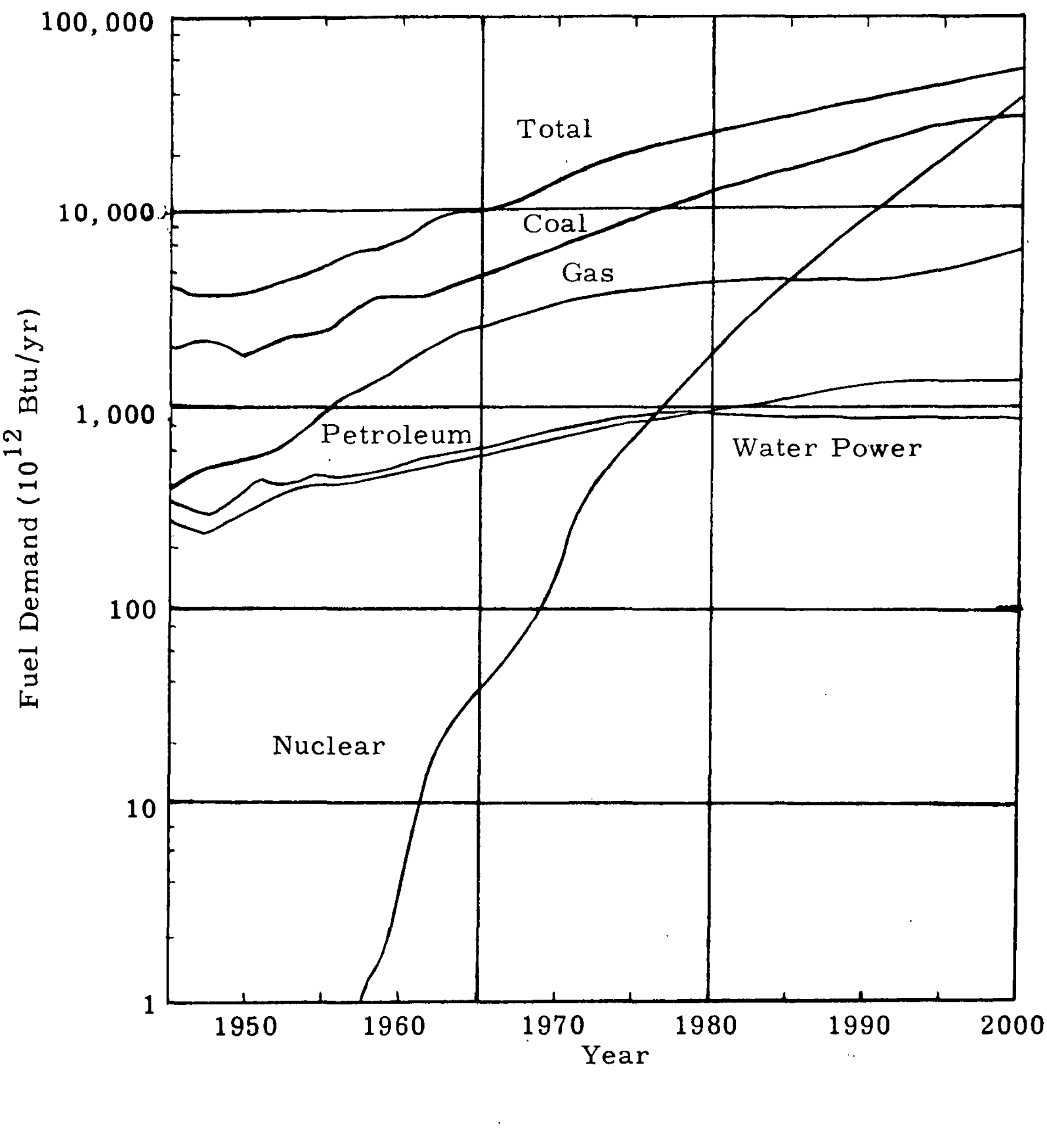


Figure III-2. Trends in Fuel Demand for Electric Power Generation (Ref. 13) during the hottest summer months when demand reached almost 33.5 billion Kw-hr. Much of this variation is due to an increasing air conditioning load. This summertime peak loading is expected to continue increasing at a significant rate. The accompanying commentary on Figure III-3 indicated a new record for power production. The item is quoted in full:

> "Electric power output in the US topped all previous records in the week ended June 26, reaching 34,090,000,000 kwhr. The previous record, 33,311,000,000 kwhr, was set in the week ended Aug. 1, 1970." (Ref. 14)

Weekly output June 26

34,090,000,000 kwhr

June 19: 32,835 June 12: 32,251

	Latest week over 1970	Cum. year to date	52 weeks to date
Total U.S.	+ 12.3	+ 5.5	+ 5.4%
New Eng.	+ 13.1	+ 6.1	+ 6.1
Mid. Atlan.	+ 17.2	+ 3.7	+ 4.5
Cent. Ind.	+ 18.8	+ 6.0	+ 4.8
West Cent.	+ 23.3	+ 5.8	+ 6.2
Southeast	+ 9.0	+ 5.3	+ 5.4
So. Cent.	+ 7.1	+ 8.6	+ 7.3
Rocky Mt.	+ 9.7	+ 8.0	+ 7.7
Pacific			
NW...........	+ 0.4	+ 2.8	+ 3.2
SW...........	+ 5.2	+ 5.2	+ 5.6

Latest seasonally adjusted index 139

Previous week 136 Year ago 123

Source: Edison Electric Institute

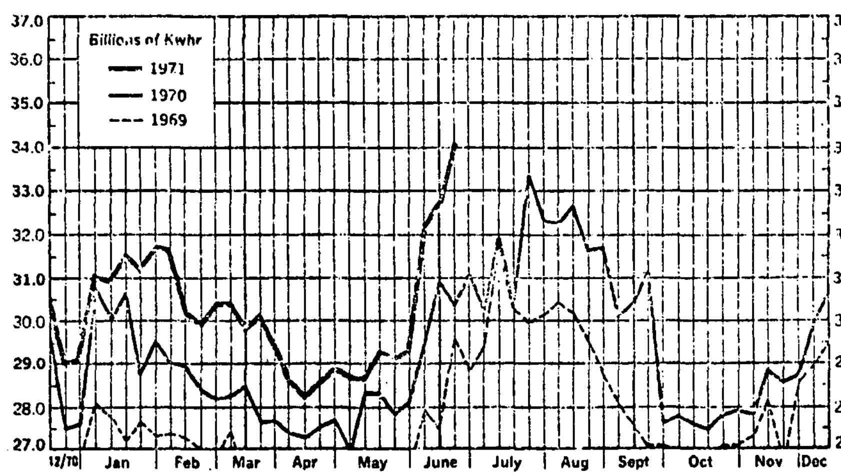


Figure III-3. Weekly Electrical Energy Output
(Ref. 14)

IV. SOURCES OF ELECTRICAL POWER

A. Types of Electrical Power Generating Plants

To meet national demands for consumable electrical power, there have been developed a number of systems to generate electrical power. These may be listed as conventional hydroelectric, pumped storage hydroelectric, fossil steam, internal combustion and gas turbine, and nuclear steam systems. A conventional hydroelectric plant uses the gravity-induced flow of naturally-deposited water from an upstream source to turn a turbine generator. This process is usually controlled by flow regulation through dams and reservoirs to provide uniform flows and a backlog of stored water. A pumped-storage hydroelectric system also uses the flow of falling water to turn a turbine generator, but makes use of off-hour generating capacity to provide power to lift water to a storage reservoir for use when required. A fossil steam plant utilizes the heat energy from the combustion of fossil fuels to convert water to steam which is then used to turn a turbine generator. Fossil fuels include bituminous, anthracite, and lignite coals; distilled, residual, and crude oils; and natural gas. Internal combustion systems utilize the explosive expansion power of fossil fuels (usually distillate oils) to turn a shaft, which is used to run a turbine generator. Gas turbines use the flow of heated exhaust gases from the combustion of fossil fuels to turn a turbine generator. A nuclear generating system utilizes the heat generated from the fissioning of nuclear fuels (usually a form of uranium) to produce steam, which then is used to turn a turbine generator.

As of 1970 in the United States, there were approximately 3400 electric power plants, of which about 1000 were major steam electric plants, and the remaining 2400 were hydroelectric, internal combustion, and gas turbine units (Ref. 8). Seventy-nine percent of present generating capacity is steam-electric; this percentage is expected to rise to 84 percent over the next 20 years. From the existing two percent nuclear fueled capacity, nuclear plants will account for approximately 40 percent of the steam-electric capacity in 1990, and almost half by the year 2000. Because of fuel availability or unforecasted technological advancements, there is some uncertainty as to the makeup of power supplied by the different types of generating sources. The information is discussed in Sections IV. D.

Electric generating plants of the various types provided a total generating capacity of approximately 330,000 Mwe in 1970. Of this, some 16 percent was hydroelectric; five percent internal combustion and gas turbine, two percent nuclear, and almost 77 percent fossil steam (Ref. 8). In the category of fossil steam units, coal presently supplies about 59 percent of the total fossil fuels consumed, oil 12 percent, and gas 29 percent (Ref. 9) for the production of electrical power.

B. Geographical Distribution of Plants and Fuels

According to the Edison Electric Institute (Ref. 10), there were a total of 339.1 million kilowatts of installed utility generating capacity at the end of 1970. These are distributed by various generating methods as indicated in Table IV-1.

TABLE IV-1. ELECTRICAL GENERATING SYSTEM DISTRIBUTION (1970)

	Percentage	Capacity(Mwe)
Conventional steam	75.3	255,342
Nuclear steam	1.4	4,747
Hydroelectric	18.1	61,377
Gas turbine/diesel	5.2	17,633
Total	100.0%	339,100 Mwe

A thorough survey was made of the geographical distribution of installed conventional steam generating facilities through the end of 1970 by type of fuel used. This information is shown in Table IV-2. Of the total 263,000 megawatts of fossil generating capacity, which has been identified in this survey, plants utilizing coal exclusively provide almost 117,000 megawatts, and plants using some combination of coal and other fossil fuels provide another 69,000 megawatts. Based on information provided (Ref. 9), a tabulation of geographic distributions of fossil fuel use has been compiled in Table IV-3. According to these data, coal provides 59 percent of national fossil fuel generated electrical power, oil 12 percent, and gas 29 percent. Historically, coal

TABLE IV-2. INSTALLED CONVENTIONAL STEAM CAPACITY (Mwe)
(through 1970)

Location*	Coal	Oil	Gas	Coal/Oil	Coal/Gas	Oil/Gas	Coal/Oil/Gas	Total
New England	691	1,735	0	5,028	0	59	3,051	10,564
Middle Atlantic	16,823	1,110	0	7,879	2,469	0	4,237	37,518
East North Central	45,343	0	0	2,652	5,052	55	3,853	56,955
West North Central	5,169	0	534	1,018	7,205	2,300	2,287	18,513
South Atlantic	26,461	3,851	42	4,423	3,900	4,851	958	44,486
East South Central	20,197	19	1,354	0	3,340	246	24	25,180
West South Central	0	0	21,170	0	40	16,673	1,500	39,383
Mountain	2,280	0	1,758	649	3,317	1,823	1,031	10,858
Pacific	0	198	0	0	0	19,227	0	19,425
Total	116,964	6,913	24,858	21,649	25,323	45,234	16,941	262,882

*Based on United States Census Regions:

New England; Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont
Middle Atlantic: New Jersey, New York, Pennsylvania
East North Central: Illinois, Indiana, Michigan, Ohio, Wisconsin
West North Central: Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota
South Atlantic: Delaware, Florida, Georgia, Maryland, District of Columbia, North Carolina, South Carolina, Virginia, West Virginia
East South Central: Alabama, Kentucky, Mississippi, Tennessee
West South Central: Arkansas, Louisiana, Oklahoma, Texas
Mountain: Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming
Pacific: California, Oregon, Washington

has held a major portion of the fuel market in areas close to sources of coal. These are called "coal competitive" areas. Table IV-4 (Ref. 9) indicates trends over the last decade in fuels selected in these coal-competitive regions.

TABLE IV-3. FOSSIL FUEL USE (PERCENT)
(1969 Data)

Location	Coal	Oil	Gas
New England	25	74	1
Middle Atlantic	60	32	8
East North Central	94	0	6
East South Central	54	1	45
South Atlantic	73	15	12
East South Central	89	0	11
West South Central	0	0	100
Mountain	51	3	46
Pacific	0	17	83
National Average	59	12	29

TABLE IV-4. FOSSIL FUEL USAGE IN COAL-COMPETITIVE AREAS (PERCENT)

	1960	1964	1965	1966	1967	1968	1969
Coal	80	81	81	80	79	77	73
Oil	6	7	8	9	10	11	14
Gas	14	12	11	11	11	12	13
Total	100	100	100	100	100	100	100

C. Near-Term Regional Growth Trends

Through announcements of utility construction plans and from various other sources, a compilation of planned construction of electrical generating facilities through 1980 has been made. In the assembly of these data, it was found that firm plans for several types of generating facilities have not been made through the end of this decade, inasmuch as design and construction of these generating facilities require relatively short time periods. For example, conventional fossil fuel steam plants average about five years for completion; nuclear plants, about seven years; hydroelectric plants vary substantially according to design and reservoir filling time; and gas turbines and diesel generating plants, about two years. However, extrapolations of this information have been made based on trends noted and on tentative planning information from various sources, as noted.

On a nationwide basis, one source of information (Ref. 9) has provided Table IV-5 which describes the mix of fuel types for new electrical power plants through 1974. Of particular note in this table are the significant yearly percentages of nuclear-fueled plants and also the sharp decline of "Other" power sources (which include internal combustion and gas turbine generators) after two years, reflecting the rapid turnaround time for installation of these units.

TABLE IV-5. TYPES OF NEW GENERATING UNITS AS A PERCENT OF TOTAL ANNUAL NEW CAPACITY IN CONTIGUOUS U.S. (Excluding West South Central and Pacific Regions)

Type of Units	1970	1971	1972	1973	1974
All conventional steam-electric units (coal, oil, and gas)	60.1	45.8	50.3	51.9	54.0
(coal-fired)	(58.8)	(39.6)	(39.4)	(41.9)	(29.5)
Nuclear	9.5	28.8	42.6	38.0	39.1
Other	30.4	25.4	7.1	10.1	6.9
Total	100.0	100.0	100.0	100.0	100.0

In order to provide additional information on near-term planning for installation of electrical generating facilities, additional reference material (Ref. 11) was obtained, from which a listing of all announced new fossil steam plants scheduled to be constructed between 1971 and 1980 was compiled. This listing is included as Appendix A. A summary of this information is provided in Table IV-6.

TABLE IV-6. FOSSIL STEAM PLANNED CONSTRUCTION (Mwe)

Location	1971	1972	1973	1974	1975	1976	1977	1978+
New England	402	465	965	400	1515	1200*	0*	0*
Middle Atlantic	1400	2371	1785	4275	3360	400	0*	0*
South Atlantic	4245	4673	5497	6162	5473	3913	0*	0*
East North Central	3890	4574	3576	1880	5626	2580	4000*	0*
East South Central	1139	3067	2045	1633	1200	0*	0*	0*
West North Central	1199	1948	1888	1525	1050	2941	1661*	0*
West South Central	5257	3740	4787	5930	5625	400*	1000*	0*
Mountain	1230	383	907	2570	2120	1520*	1000*	0*
Pacific	1705	1895	1077	750	0	0*	0*	0*
Total	20,467	23,116	22,527	25,125	25,969	12,954*	7661*	0*

*Additional units may be ordered.

In the summary table of planned construction, it should be noted that some plants may have been included more than once in reaching final totals, partially due to either a name change on a plant or a plant relocation. It should be further noted that construction plans for large fossil units are relatively firm through 1975, but more plants than are indicated may be ordered and placed in service from 1976 onward because of the construction lead time.

At the end of 1970, there were approximately 6100 megawatts of nuclear powered electrical generation capacity operable in the United States. During the next decade, some 114,000 megawatts of nuclear capacity are scheduled for operation (Ref. 11). In addition, 25,000 megawatts of hydroelectric capacity and 11,000 megawatts of internal combustion and gas turbine units are also scheduled for operation during this period, although in the latter two cases, substantially more capacity than is currently in planning will be ordered and placed in service during this time period. Table IV-7 shows the scheduled on-line nuclear capacity through 1980 by census region, and Tables IV-8 and IV-9 show hydroelectric and peaking (internal combustion/gas turbine) capacities scheduled during the same period. Table IV-10 shows the sum total of all electrical power generating plants presently announced for construction during the next decade in the United States.

In Table IV-10, it is significant that the total amount of planned capacity presently announced in mid-1971 is over 286,000 megawatts. With a total forecasted requirement in 1980 of 560,000 megawatts and an existing capacity of 330,000 megawatts, the announced 286,000 megawatts more than compensates for the 230,000 megawatts difference between existing and planned capabilities. Of course, these figures make no allowance for the retirement of obsolete, inefficient older plants, which will make up a large portion of the difference. There are no data available in current literature on retirement of obsolete units, either historical or predictive; however, the general trend of utilities has been to use their older units at lower and lower plant load factors with increasing age, and to finally place these units on cold standby, especially in areas of marginal capacity. It should be noted regarding Tables IV-6 through IV-10 that the totals may differ somewhat from similar data due to the disparity of sources of the basic information and also because of slipped or accelerated construction schedules.

TABLE IV-7. NUCLEAR STEAM PLANNED CONSTRUCTION (Mwe)

Location	1971	1972	1973	1974	1975	1976	1977*	1978+*	Total
New England	1235	830	0	828	0	0	0	3300	6,193
Middle Atlantic	873	1875	4710	1860	4315	1000	4315	7535	26,483
South Atlantic	3009	3201	2441	2590	2910	2434	3890	3640	24,115
East North Central	3106	2292	2104	3633	2732	2610	0	0	16,477
West North Central	0	987	778	1080	0	0	1000	3350	7,195
East South Central	0	1075	2150	2440	829	1100	3129	1200	11,923
West South Central	0	0	850	0	480	850	2150	0	4,330
Mountain	0	330	0	0	0	0	0	0	330
Pacific	0	0	5020	0	462	2100	5400	4100	17,082
Total	8223	10,590	18,053	12,431	11,728	10,094	19,884*	23,125*	114,128

*Additional units may be ordered.

TABLE IV-8. HYDROELECTRIC PLANNED CONSTRUCTION (Mwe)

Location	1971	1972	1973	1974	1975	1976*	1977+*	Total
New England	750	1250	0	600	0	0	0	2,600
Middle Atlantic	205	606	735	0	0	3000	0	4,546
South Atlantic	210	84	1872	0	0	2250	0	2,544
East North Central	0	0	1872	0	0	0	0	1,872
West North Central	135	0	36	0	0	0	0	171
East South Central	933	1116	320	1783	2017	0	0	6,169
West South Central	0	93	0	0	0	0	0	93
Mountain	258	0	600	0	0	500	0	1,358
Pacific	728	718	1682	1598	800	400	0	5,926
Total	3219	3867	5245	3981*	2817*	6150*	0*	25,279

*Additional units may be ordered.

TABLE IV-9. PEAKING UNIT PLANNED CONSTRUCTION (Mwe)

Location	1971	1972	1973*	1974+*	Total
New England	0	45	40	0	85
Middle Atlantic	2977	755	312	0	4,044
South Atlantic	1552	368	200	0	2,120
East North Central	789	142	0	0	931
West North Central	4	690	160	616	1,470
East South Central	493	600	0	0	1,093
West South Central	135	50	166	50	401
Mountain	77	254	126	0	457
Pacific	0	233	180	0	413
Total	6027	3137	1184*	666*	11,014

*Additional units may be ordered.

TABLE IV-10. TOTAL UNITED STATES ANNOUNCED CONSTRUCTION (Mwe)

Location	1971	1972	1973	1974*	1975*	1976*	1977*	1978+*	Total
New England	2,387	2,590	1,005	1,828	1,515	1,200	0	3,300	13,825
Middle Atlantic	5,455	5,607	7,542	6,135	7,675	4,400	4,315	7,535	48,664
South Atlantic	9,016	8,326	8,138	8,752	8,383	7,597	3,890	3,640	57,742
East North Central	7,785	7,008	7,552	5,513	8,358	5,190	4,000	0	45,406
West North Central	1,278	4,744	3,019	3,329	1,200	0	1,000	3,350	17,920
East South Central	2,625	4,739	4,358	5,748	3,896	4,041	4,790	1,200	31,397
West South Central	5,392	3,883	5,803	5,980	5,105	1,250	3,150	0	30,563
Mountain	1,565	967	1,633	2,570	2,120	2,020	1,000	0	11,875
Pacific	2,433	2,846	7,959	2,348	1,262	2,500	5,400	4,100	28,848
Total	37,936	40,710	47,009	42,203*	39,514*	28,198*	27,545*	23,125*	286,240

*Additional units may be ordered.

D. Long-Term Growth Trends

The United States Census Bureau has prepared estimates of population changes by census region for the years 1975 and 1985 (Ref. 1). In order to arrive at an estimate of regional population through 2050, individual regional growth rates were assumed to remain reasonably constant throughout the forecast period and were used to extrapolate population curves during the period of interest. Data used and calculated are shown in Table IV-11, illustrating numerical changes by region as projected by the Census Bureau.

Table IV-11, based on projected growth rates over the next 15 years and then projected through 2050 at the same growth rates, probably tends to overestimate growths in certain areas, particularly in the Pacific region. However, lacking any additional information, these figures were used to assess regional power demands.

Assuming no interregional mass export or import of large quantities of electrical power, implying that each region produces almost all of the electrical power used within it, and applying the per capita demand of electrical power through the period to 2050,as selected in Section II, Table IV-12 shows the expected net usage by region and decade for the next 80 years.

In Table IV-12, the total additive capacities are based on the projections made in Section II of this report and are thought to be reasonable estimates of capacity requirements through 2050, although there is a large uncertainty factor beyond the turn of the century. The straight-line projections of regional requirements based on population trends and per capita usage may be somewhat misleading, inasmuch as there may be substantial savings of regional growth which cannot be accurately predicted at present.

E. Long-Term Fuel Types

Based on predictions of electrical energy supplied by fossil, nuclear, and hydroelectric sources (Refs. 7, 14, 15, 16, 17, 18, 19, 20) through about 2020, an assessment was made of the probable distribution of fuel categorized utility power supplies through 2050. As in previous sections of this report, uncertainties on power supply system developments and on the economics and

TABLE IV-11. REGIONAL POPULATION TRENDS TO 2050 (Millions)

Location	1965*	1975**	1985**	2000	2010	2020	2030	2040	2050
New England	11.1	12.5	14.5	16.9	18.7	21.3	23.4	25.6	28.1
Middle Atlantic	36.2	40.7	46.5	51.6	55.4	60.8	65.3	70.0	75.6
South Atlantic	28.8	34.2	41.4	50.0	56.1	65.1	74.8	85.4	97.2
East North Central	38.3	42.5	49.7	55.9	60.5	67.8	73.5	79.6	86.9
West North Central	15.9	16.9	19.0	19.3	19.7	20.2	20.3	20.3	20.0
East South Central	12.8	14.2	16.1	18.1	19.7	21.7	23.4	25.6	27.0
West South Central	18.5	21.5	25.1	29.2	32.3	36.4	40.7	44.9	52.4
Mountain	7.7	9.4	11.7	14.1	16.0	19.0	22.1	25.6	29.2
Pacific	24.3	30.8	39.5	51.9	61.5	75.2	89.1	105.7	125.3
Total	193.6*	222.7**	263.6**	307.0	340.0	390.0	430.0	480.0	541.7

* Existing data
** U.S. Census Bureau projection
\+ Population values based on Series "C" Census Bureau data

TABLE IV-12. REGIONAL NET ELECTRICAL POWER CAPACITY (1970-2050) (10^3 Mwe)

Plant load factor	0.64	0.64	0.65	0.66	0.68	0.72	0.75	0.78	0.80
Per capita use	0.9	1.5	2.4	3.2	4.0	5.0	6.0	6.8	7.7

Location	1970	1980	1990	2000	2010	2020	2030	2040	2050
New England	18	31	54	82	110	147	187	223	270
Middle Atlantic	59	101	171	250	326	420	522	609	728
South Atlantic	49	87	157	243	330	449	599	743	936
East North Central	62	106	182	271	356	468	588	693	837
West North Central	25	41	67	94	116	139	163	176	192
East South Central	21	35	60	88	116	150	187	223	260
West South Central	31	53	93	142	190	251	325	391	489
Mountain	13	24	44	69	94	131	176	223	281
Pacific	42	81	153	252	362	519	713	919	1206
Total	320	560	980	1490	2000	2675	3460	4200	5200

technologies of fuel supplies beyond about 2000 introduce increasing unreliability into these forecasts with increasing time into the future. However, the existing forecasts are in reasonable agreement and appear to provide a firm basis for extrapolation to 2050. In these forecasts, the assumption has been made that a very large percentage of nuclear power will be supplied by breeder and advanced converter reactors after about 1985.

From the sources referenced above, only trend lines may be derived for the portion of electrical energy production met by any given fuel. The data contain some conflicts in estimates, but largely tend to agree within approximately 10 percent. In order to present these data on fuels for power supplies, estimates were made on fuel distributions based on the various estimates available. The results of these estimates are shown in Table IV-13.

TABLE IV-13. PROJECTED POWER CAPACITY BY FUEL (Mwe x 10^3)

Fuel	1970	1980	1990	2000	2010	2020	2030	2040	2050
Coal	176	280	412	566	640	615	595	510	416
Oil	22	34	49	60	76	58	52	45	40
Gas	61	84	108	119	115	103	93	85	80
Hydro	51	62	69	89	90	95	100	102	104
Nuclear	10	106	343	671	1080	1825	2660	3458	4560
Total	320	570	980	1500	2000	2700	3500	4200	5200

As recently indicated (Ref. 21), the major factor affecting coal is the cost of production; nuclear, the cost of preparation; gas, government regulation; and oil, the market opportunities. Neither gas nor oil prices lend themselves to statistical analysis, but both nuclear fuel and coal costs can be examined in some detail. Because of escalations to be realized in the next few decades, coal prices are expected to more than double. Since nuclear fuel costs will remain reasonably constant during the same time period due to introduction of breeder reactors, this, too, will significantly affect the desirability of nuclear power over coal, particularly in light of increasingly stringent regulations on coal sulfur contents. Figure IV-1 shows fuel cost projections over the next 15 years.

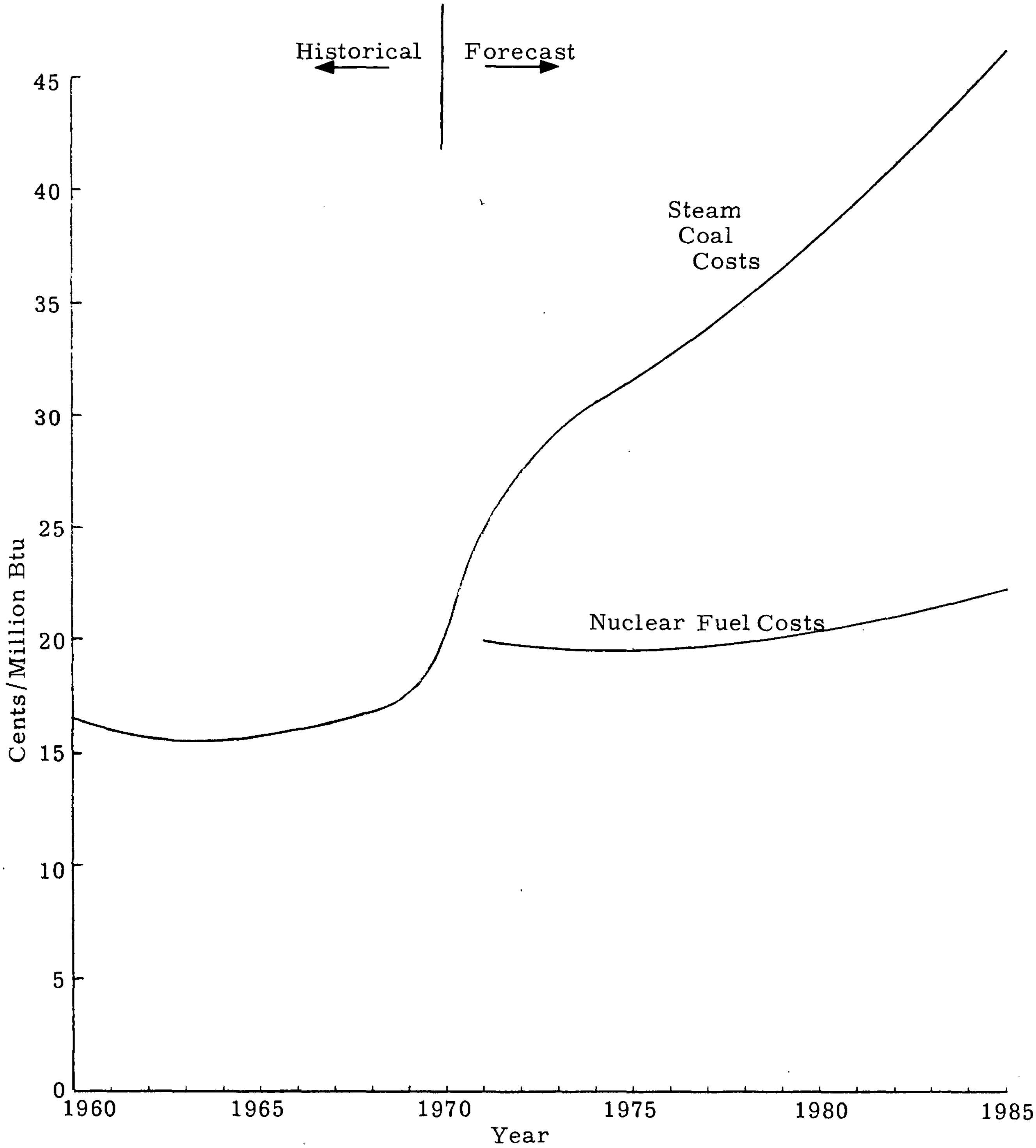


Figure IV-1. Projection of Fuel Costs (Ref. 21)

V. SUMMARY AND CONCLUSIONS

On the basis of predicted populations and per capita electrical power usage through the year 2050, forecasts of electrical generating capacities have been derived. These forecasts were broken down by regions and by expected fuel usage. In arriving at these forecasts, some basic assumptions have been made, including the assumption that breeder reactors will be commercially available around 1985, and that plant load factors will gradually increase from about 60 percent in 1970 to almost 80 percent in 2050 through improved engineering systems technology, better and more complete transmission facilities, greater plant reliability, improved methods of long-range power dispatching, and other factors.

These studies indicate that total installed power capacity will increase from about 320,000 megawatts in 1970 to about 1,000,000 megawatts in 1990, about 1,500,000 in 2000, and 5,200,000 in 2050. Fossil fuels supply about 83 percent of utility power in 1970. Fossil fuel use will decrease to about 50 percent in 2000 and to about 11 percent in 2050, while nuclear power will increase from the present 3 percent to about 45 percent in 2000 and to about 88 percent in 2050. Although hydroelectric power shows a gradual increment throughout the forecast period, it is far outstripped by other power sources and provides consistently smaller percentages of total power capacities.

Based on the information collected to prepare this report, there is reasonable agreement on the amounts of electrical power which will be required to supply the needs of the United States through the next several decades. Trend analysis and extrapolation has been used to predict longer-term power requirements, but confidence levels decrease significantly with longer time periods. Nevertheless, barring any major unforeseen developments, such as cataclysm, catastrophe, or revolutionary scientific discovery, there appears to be reasonable certainty that national electrical power demands and supplies will approximate the growth curves delineated in this report.

Several areas of additional study are suggested from the work required to complete this report. Most particularly, there is some doubt regarding per capita use of electricity in the future. It is therefore recommended that additional efforts be expended to evolve some firm idea of electrical power usage in the future. Closely allied to this is the need to assess the effects of economics on power demand. That is, the effect of increasing prices of electrical power - which may be caused by increasing fuel prices, scarcity of power, or more stringent environmental protection controls on the utility industry - on user demand should be evaluated to determine how economic controls may be used to regulate or minimize environmental impacts from the production of electrical power. Additionally, there would appear to be some saturation level in the home of electrically powered devices such as can openers, air conditioners, dryers, etc., which can be productively utilized at the same time, and accordingly some limit to power usage on a per capita basis.

There is some question on how to most effectively utilize generating capacity to minimize the ratio of demand to capacity. An examination of optimal energy use policies from an emission control standpoint would provide operational guidelines for achieving maximum possible effective emission controls. For example, with the major increment in nuclear plants, the most efficient operation would be application of the nuclear plant to base load, and the use of fossil, pumped storage, and peaking units to load following, thereby minimizing combustion product emissions to the atmosphere. It is clear that the choice of energy utilization will have an effect on atmospheric emissions and, therefore, indirectly on air quality.

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APPENDIX A

FOSSIL STEAM CONSTRUCTION PLANS 1971-1980

TABLE A-1

CENSUS REGION: NEW ENGLAND

(Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut)

State	Fossil Plant Name	Utility	1971	1972	1973	1974	1975*	1976*	Heat Rate, Btu/Kw-hr
Maine	None								
N.H.	Seabrook (Schiller)	P.S.N.H.				400(O)			10,000
Vt.	Unnamed	Cent. Vt. PSC						400(O)	
Mass.	Salem Harbor 4	N. Eng. Elec.		465(O)					10,400
	Gleary 9	Taunton Munic.			100(O)				12,000
	Brayton Point 4	N. Eng. Elec.			465(O)				10,400
	Mystic 2	Bost. Ed.					600(O)		
	Canal 2	Canal Elec. Co.					515(O)		
R.I.	None								
Conn.	Montville 6	Ct. Lt. &Pwr.	402(O)						10,650
	Middletown 4	Hartford E. L.			400(O)				10,000
	Cokeworks 1	Un. Illum.					400(O)		
	Unnamed	Hartford E. L.						800(O)	
Region Total			402	465	965	400	1515*	1200*	

*Additional units may be ordered.

TABLE A-2

CENSUS REGION: MIDDLE ATLANTIC

(New York, New Jersey, Pennsylvania)

State	Fossil Plant Name	Utility	1971	1972	1973	1974	1975*	1976*	Heat Rate, Btu/Kw-hr
New York	Roseton 2	Cent. Hudson			600(O)				9,100
	Astoria 6 & 7	Con Ed				1600(C)			8,800
	Oswego 5	Niag. Moh.				875(C,G)			8,600
	Northport	LILCO		386(O)					9,000
	Roseton 1	Cent. Hud.		600(O)					9,100
	Bowline 1 & 2	Or. &Rock		600(O,G)		600(G,O)			9,500
	Unassigned	Con Ed.					1200(C/O)		9,000
N. J.	Linden 4	PSE&G	80(O)						9,500
	Sewaren 7	PSE&G			400(O)				10,000
	Seawaren 8	PSE&G					400(O)		10,000
	England 3	Atl. Cty. Elec.					160(O)		
Penna.	Conemaugh 2	Con. Grp.	820(C)						8,800
	Hatfield Ferry 3	APS	500(C)						9,500
	Montour 1	PP&L		785(C)					8,890
	Montour 2	PP&L			785(C)				8,850
	Eddystone 3 & 4	Phila. Elec.				400(C)		400(O)	10,000
	Unassigned	Duquesne					800(C)		9,200
	Martin's Creek 3 & 4	Penn. P&L				800(O)	800(O)		
Region Total			1400	2371	1785	4275	3360*	400*	

*Additional units may be ordered.

TABLE A-3

CENSUS REGION: SOUTH ATLANTIC

(Delaware, D.C., Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia)

State	Fossil Plant Name	Utility	1971	1972	1973	1974	1975*	1976*	Heat Rate, Btu/Kw-hr
Dela.	Edgemoor 5	Delvarva			400(C,G)				10,100
D.C.	Benning 16	Pepco		275(O)					11,243
Florida	Gainesville	Gaines. Munic.	81(O)						
	Northside 2	Jax. Munic.	268(O)						7,614
	Stock Island 1	Key West Munic.	33(O)						12,000
	Lake Worth S4	Lk. Worth Munic.	33(G)						12,570
	Hopkins 1	Talahassee Munic.	81(O,G)						10,300
	Vero Beach 3	Vero Bch. Munic.	36(O,G)						12,000
	Sanford 4	FP&L		398(O)					9,383
	Crist 7	Gulf Pwr.			505(C)				9,000
	Indian River 3	Orlando Munic.			327(O,G)				8,163
	Big Bend 2	Tampa Elec.			434(C)				9,100
	Anciote 1	FPC				510(G,O)			9,800
	Port Manatee 1	FP&L					762(O)		9,200
	Sanford 5	FP&L		420(O)					
Georgia	Etowah 1	Ga. Pwr.	705(C)						8,500
	Port Wentworth 4	Savannah E&P	121(G)						9,843
	Etowah 2	Ga. Pwr.		705(C)					8,800
	Effingham 1	Savannah E&P				175(C)			9,500
	Etowah 3	Ga. Pwr.				876(C)			8,800
	Etowah 4	Ga. Pwr.					850(C)		
Md.	Vienna 8	Delmarva	150(O)						10,750
	Morgantown 2	Pepco	558(O,C)						8,600
	Wagner 4	BG&E		415(O)					10,400
	Sandy Point 1	Pepco				403(C,O)			10,000
	Northern 1	Pepco					768(O)		8,850
	Northern 2	Pepco						768(O)	8,850
	Chalk Point	Pepco				630(O)			

TABLE A-3
CENSUS REGION: SOUTH ATLANTIC
(Continued)

State	Fossil Plant Name	Utility	1971	1972	1973	1974	1975*	1976*	Heat Rate, Btu/Kw-hr
N.C.	Asheville 2(Skyland 2)	CP&L	194(C)						9,450
	Sutton 3	CP&L		420(O,C)					9,200
	Cliffside 5	Duke		590(C)					7,855
	Roxboro 3	CP&L			720(C)				9,100
	Belews Creek 1	Duke				1143(C)			7,485
	Belews Creek 2	Duke					1143(C)		7,485
S.C.	Wateree 2	S.C. E&G	385(C)						8,780
	Bushy Park 1	S.C. E&G			600(C)				8,900
	Georgetown	S.C. PSA				280(O,C)			9,300
Va.	Mount Storm 3	VEPCO			561(C)				9,000
	Yorktown 3	VEPCO				845(O)			8,700
	Northern Virginia	VEPCO						845(O)	
W.Va.	Amos 1	APC	800(C)						8,700
	Mitchell 2	APC	800(C)						8,660
	Amos 2	APC		800(C)					8,700
	Harrison 1	Mon. Pwr.		650(C)					7,870
	Harrison 2	Mon. Pwr.			650(C)				7,870
	Amos 3	APC			1300(C)				7,600
	Unassigned 1	AEP				1300(C)			7,600
	Harrison 3	APC					650(C)		7,870
	Unassigned 2	AEP					1300(C)		7,600
	Unassigned 3	AEP						1300(C)	7,600
	Region Total		4245	4673	5497	6162	5473*	2913*	

*Additional units may be ordered.

TABLE A-4

CENSUS REGION: EAST NORTH CENTRAL

(Illinois, Indiana, Michigan, Ohio, Wisconsin)

State	Fossil Plant Name	Utility	1971	1972	1973	1974	1975*	1976*	1977-80*	Heat Rate, Btu/Kw-hr
Ill.	Edwards 3	Cent. Ill.		350(C)						7,754
	Coffeen 2	Cent. Ill. PSC		600(C)						9,384
	Powerton 5	CE Co.		840(C)						9,800
	Dallman 2	Spgfld. Munic.		80(C)						10,287
	Baldwin 2 & 3	Ill. Pwr.			600(C)		600(C)			9,203
	Unnamed	Cent. Ill. PSC						600(C)		
	Unnamed	Ill. Pwr.							4000(C)	
Ind.	Cayuga 2	PSC Ind.		500(C)						9,300
	Stout 7	Indianapolis			450(C)					9,115
	Mitchell 12	NIPSCO			520(C,G)					9,350
	Culley 3	SIG &E			250(C)					8,391
	Princeton 1 & 2	PSC Ind.					650(C)	650(C)		8,800
	Petersburg 3	Indianapolis						450(C)		9,100
	Richmond	Richmond Munic.		60(C,O,G)						
	Unnamed	NIPSCO					500(C)			
Mich.	Monroe 1	Det. Ed.	765(C)							8,710
	Monroe 2	Det. Ed.	765(C)							8,710
	Monroe 3	Det. Ed.		789(C)						8,700
	Monroe 4	Det. Ed.			786(C)					8,710
	Karn 3	Con. Pwr.					660(C)			8,800
	Presque Isle 5 & 6	U. P. Gen.	170(C)		170(C)					9,400
	Ottawa	Lansing		150(C)						9,500
Ohio	Coleman 3	Big. Riv. Coop.	185(C)							9,600
	Stuart 1	Dayt. P&L	580(C)							8,898
	Sammis 7	O. Ed.	625(C)							8,803
	Eastlake 5	Clev. Elec.		625(C)						8,750
	Stuart 3	Dayt. P&L		580(C)						8,898
	Conesville 4	Col. &S. O.			800(C)					8,744
	Stuart 4	Dayt. P&L				580(C)				8,940
	Mansefield 1	O. Ed.					880(C)			8,600
	Mansefield 2	O. Ed.						880(C)		8,700
	Gavin 1 & 2	O. Pwr.				1300(C)	1300(C)			
	Mitchell 2	O. Pwr.	800(C)							
	Miami Fort	Day. P&L					550(C)			
Wisc.	Columbia 1	Wisc. P&L					486(C)			9,000
Region Total			3890	4574	3576	1880	5626*	2580*	4000*	

*Additional units may be ordered.

TABLE A-5

CENSUS REGION: EAST SOUTH CENTRAL

(Alabama, Kentucky, Mississippi, Tennessee)

State	Fossil Plant Name	Utility	1971	1972	1973	1974	1975*	1976*	Heat Rate, Btu/Kw-hr
Ala.	Barry 5	Ala. Pwr.	712(C)						9,200
	Gorgas 10	Ala. Pwr.		712(C)					8,800
	Gaston 5	Ala. Pwr.				876(C)			8,600
Ky.	Brown 3	Ky. Util.	427(C)						9,400
	Mill Creek 1	L'ville. G&E		330(C)					9,300
	Smith 2	Owensboro Mun.			265(C)				9,490
	Ghent 1	Ky. Util.				427(C)			9,308
	Mill Creek 2	L'ville.G&E				330(C)			9,300
	Ohio River 1	E. Ky. R. E. C.					450(C)		
Miss.	Watson 5	Miss. Pwr.			505(C)				9,318
	Wilson 2	Miss. P&L		750(G)					8,000
	Andrus 1	Miss. P&L					750(G)		
Tenn.	Cumberland 1	TVA		1275(C)					8,872
	Cumberland 2	TVA			1275(C)				8,872
	Region Total		1139	3067	2045	1633	1200*	0*	

*Additional units may be ordered.

TABLE A-6

CENSUS REGION: WEST NORTH CENTRAL

(Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota)

State	Fossil Plant Name	Utility	1971	1972	1973	1974	1975*	1976*	1977-8*	Heat Rate, Btu/Kw-hr
Iowa	Neal 2 & 3	Ia. P. S.		325(C)				500(C)		9,100
	Municipal 7	Pella		29(C)						9,900
	Municipal 8	Muscatine	66(C)							10,000
Kans.	Lawrence 5	Kans. P&L	430(C,G)							9,400
	Quindaro 3-2	K. C. Elec.		145(C,G)						8,180
	Garden City 1	S'flr. Elec. Coop.		94(G)						9,800
	LaCynge 1	K. C. P&L			848(C)					8,700
	Hutchinson 5	K. P&L				225(O,G)				9,600
Minn.	Austin 1	Austin Munic.	30(C,G)							11,500
	Virginia Munic. 6	Virg. Munic.	19(C)							11,400
	Boswell 3	Minn. P&L			350(C)					9,200
	Unassigned 1 & 2	Interst. Pwr.						216(C)	216(C)	9,400
	Shelbourne 1	Nor. St. Pwr.						725(C)		
Mo.	Labadie 2	Union Elec.	600(C)							9,230
	Labadie 3	Union Elec.		600(C)						9,230
	Labadie 4	Union Elec.			600(C)					9,230
	Rush Island 1	Union Elec.					600(C)			8,900
	Rush Island 2	Union Elec.						600(C)		8,900
	New Madrid 1	N. Mad. Munic.		600(C)						9,500
	New Madrid 2	Asso. Elec. Coop.				600(O,G)				9,400
	Plant X	Mo. P. S.						400(O,G)		9,400
	Asbury 2	Emp. Dist. Elec.							300(G,O)	9,700
	Lake Road	St. Jos. L&P						200(C,G)		9,900
	Follows Lake	Spgfld. Util.				150(C)				9,300
	James River 6	Spgfld. Util.				112(C)				
	Independence	Ind. Munic.							145(C)	
Neb.	Moorhead Mun. 5	M'head Munic.	54(O, G)							10,000
	Omaha 906	OPPD		100(O,G)						9,900
	Freemont	Freemont Munic.		55(O, G)						
	North Platte 3 & 4	Neb. PPD							1000(O,G)	
N. D.	Olds 2	Basin Elec. Pwr. Coop.				438(C)				8,500
S. D.	Otter Tail 6 (Big Stone)	Otter Tail Pwr.					450(C)			8,500
	Region Total		1199	1948	1798	1525	1050*	2641*	1661*	

*Additional units may be ordered.

TABLE A-7

CENSUS REGION: WEST SOUTH CENTRAL

(Arkansas, Louisiana, Oklahoma, Texas)

State	Fossil Plant Name	Utility	1971	1972	1973	1974	1975*	1976*	Heat Rate, Btu/Kw-hr
Ark.	McClellan 1	Ark. Elec. Coop.	133(G)						9,900
	Bailey 2	Ark. Elec. Coop.				200(G)			
La.	Houma 9	Houma Munic.	26(G)						10,000
	Louisiana 1	La. El. Coop.	115(G,O)						9,800
	Louisiana 2	La. El. Coop.	115(G,O)						9,800
	Nine Mile Point 4	La. P&L	750(G,O)						8,000
	Natchitoches Mun. 10	Natch. Munic.	27(G)						10,000
	Plaquemine Munic.	Plaq. Munic.	26(G)						10,000
	Willow Glen 4	Gulf St. Util.		580(G)					9,250
	Thibodaux Munic.	Thib. Munic.		20(G)					10,000
	Alexandria Munic. 4	Alex. Munic.			92(G)				9,800
	Nine Mile Point 5	La. P&L			750(G,O)				8,000
	Louisiana Y	Gulf St. Util.				580(G,O)			9,400
	Waterford 1 & 2	La. P&L				430(G,O)	430(G,O)		9,600
	Unassigned	Cent. P&L					325(G)		9,600
	Louisiana Z	Gulf St. Util.					750(G,O)		8,000
	Teche 3 & 4	Cent. La. Elec.	350(G)			440(G,O)			9,600
	Plant X-1	Cent. La. Elec.					430(G,O)		
Okla.	Seminole 1	Okla. G&E	550(G)						9,600
	Seminole 2 & 3	Okla. G&E			550(G)		550(G)		9,700
	Northeastern 3	PSC Okla.				450(O,G)			9,600
	Unassigned	Okla. G&E					550(G,O)		9,700
	Andarko 3 & 4	Wstrn. Farmers		200(G)	135(G)				9,500
	Jenks 1 & 2	PSC Okla.			450(O,G)		450(O,G)		
Texas	Miller 2	Brazos E.P. Coop.	116(G)						9,900
	Joslin 1	Cent. P&L	240(G)						9,800
	Lewis Creek 2	Gulf St. Util.	265(G)						9,655
	Cedar Bayou 2	Houston L&P	750(G)						7,828
	Jones 1	S'western PSC	244(G)						9,945
	Eagle Mountain 3	Tex. Elec. Svc.	375(G)						12,000
	Valley 3	Tex. P&L	375(G)						9,500
	Big Brown 1	Tex. Util.	575(C)						9,710
	Paint Creek 4	W. Tex. Util.	107(G)						9,970

TABLE A-7

CENSUS REGION: WEST SOUTH CENTRAL

(Continued)

State	Fossil Plant Name	Utility	1971	1972	1973	1974	1975*	1976*	1977*	Heat Rate Btu/Kw-hr
Tex. (cont'd)	Nueces Bay 7	Cent. P&L		325(G)						9,652
	Rio Grande 8	El Paso Elec.		165(G,O)						7.981
	Gideon 3	Lwr. Colo. R. Auth.		325(G)						9,500
	Calaveras 1	San Antonio		430(O,G)						7,947
	Wilkes 3	SW Elec. Pwr.		345(G)						9,770
	Tradinghouse Cr. 2	Tex. P&L		775(G)						9,400
	Big Brown 2	Tex. Util.		575(C)						9,710
	Lake Hubbard 2	Dallas P&L			515(O,G)					8,217
	Sabine 4	Gulf St. Util.			580(G)					9,385
	Greens Bayou 5	Houston L&P			425(G,O)					9,800
	Robinson 4	Houston L&P			750(G)					8,000
	Permian Basin 6	Tex. Elec. Svc.			540(G,O)					9,700
	Holly 4	Austin Munic.				190(G)				9,500
	Barney Davis 1	Cent. P&L				325(G,O)				9,600
	Cedar Bayou 3	Houston L&P				750(G,O)				8,000
	Baird Ranch 1	Lwr. Colo. R. Auth.				430(G,O)				9,600
	Calaveras 2	San Antonio				430(O,G)				7,936
	Lee 5	SW Elc. Pwr.				360(O,G)				9,700
	Jones 2	SW PSC				244(G)				9,800
	Phantom Hill 1	W. Tex. Util.				175(G)				9,900
	Garland 2	Garland Munic.	118(G,O)							
	Monticello	Dallas P&L				576(G,O)				
	Lake Avon 2	Garland Munic.				150(G,O)				
	Plant A-1	SWPSC				200(G)				
	Unnamed	El Paso Elec.					160(G)			
	Unnamed	Gulf St. Util.					580(O)			
	Unnamed	Tex. Elec. Svc.					400(G)	400(G)		
	Bayou 5	Houston L&P							1000(G,O)	
Region Total			5257	3740	4787	5930	4625*	400*	1000	

*Additional units may be ordered.

TABLE A-8
CENSUS REGION: MOUNTAIN
(Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming)

State	Fossil Plant Name	Utility	1971	1972	1973	1974	1975*	1976*	1977-8*	Heat Rate, Btu/Kw-hr
Ariz.	Navajo 1	Salt R. P. D.				770(C)				9,200
	Navajo 2	Salt R. P. D.					770(C)			9,200
	Navajo 3	Salt R. P. D.						770(C)		9,200
	Unnamed	Salt R. P. D.						250(C)		
Colo.	Lamar Munic.	Lamar Munic.		28(O, G)						12,500
	Drake 7	Colo. Spr. Munic.			132(G)					9,900
	Comanche 1	PSC Colo.				360(C)				9,068
Idaho	American Falls 1	Idaho Pwr.			430(C)					9,000
	Bridger 1	Idaho Pwr.				500(C)				9,000
	Bridger 2	PP&L					500(C)			9,000
	Bridger 3	PP&L					500(C)			9,000
	Bridger 4	PP&L							500(C)	
Mont.	Miles City 1	Mont.-Dak. Util.		25(O,G)						10,100
	Unassigned	Mont. Pwr.					350(C)			9,200
Nev.	Mohave 2	SoCalEd	790(C)							9,100
	Fort Churchill 2	Sierra Pac.	110(O,G)							12,000
	Tracy 3	Sierra Pac.				110(O,G)				
N. Mex.	San Juan 2	PSCNM			345(C)					9,200
	Unnamed	N. M. Elec. Svc.				400(G)				
Utah	Huntington Canyon 1, 2, &4	Utah P&L				430(C)		500(C)	500(C)	9,100
Wyo.	Naughton 3	Utah P&L	330(C)							9,550
	Johnston 4	PP&L		330(C)						10,500
	Region Total		1230	383	907	2570	2120*	1520*	1000*	

*More units may be ordered.

TABLE A-9

CENSUS REGION: PACIFIC

(California, Oregon, Washington)

State	Fossil Plant Name	Utility	1971	1972	1973	1974	1975*	1976*	Heat Rate, Btu/Kw-hr
Cal.	South Bay 4	San Diego G&E	215(G,O)						11,204
	Ormond Beach 1	So. Cal. Ed.	790(O,G)						9,057
	Pittsburg 7	PG&E		735(G,O)					8,200
	Scattergood 3	LADWP		460(G)					8,980
	Encina 4	San Diego G&E			287(O,G)				11,000
	Ormond Beach 2	So. Cal. Ed.			790(O,G)				9,057
	Victorville	So. Cal. Ed.				750(O,G)			9,000
Ore.	None								
Wash.	Centralia 1	PP&L	700(C)						9,700
	Centralia 2	PP&L		700(C)					9,700
Region Total			1705	1895	1077	750	0*	0*	

*Additional units may be ordered.